

The national oil company of Malaysia is exploring and producing oil and gas in Malaysia and internationally. A need was identified to improve capabilities of the oil company's exploration staff in the area of trap identification and analysis. Closely linked with trap analysis is the understanding of seal efficiency of both top and fault seals.

A 5-day exercise-rich course was developed to address this: **Trap, top- and fault-seal analysis**. Trap and seal analyses are discussed in this course from a pragmatic explorers point of view, based on the extensive experience of the instructor and on published case histories. A large variety of trap types from different basin settings are discussed and illustrated with real examples from basins across the globe. The theoretical aspects of trapping and sealing are also presented and discussed, but emphasis is on providing real examples, doing exercises and providing advice and practical guidelines that help explorers in their day-to-day work.

On completion of the course, exploration staff was able to:

- ✓ Identify the critical aspects of identified prospects
- ✓ Understand the theory of sealing and sealing capacity
- ✓ Understand sealing mechanisms and reasons for seal failure
- ✓ Identify geological situations in which fault seals are more likely to work
- ✓ Determine the risk that Trap or Seal in a prospect does not work
- ✓ Understand the role of seals in the differential trapping of oil and gas
- ✓ Make realistic predictions for hydrocarbon column lengths in undrilled prospects



Satisfied with the results of the initial course in 2017, the national oil company has continued to register exploration staff to following runs of the course in 2018, with courses for 2019 in the planning. The course can be run as a public course and also as in-house course for interested companies. An in-house course has the advantage that company-specific prospects and situation can be fully discussed in the context of the learnings of the course.

The Surinam's state oil company, producing some 25,000 BOPD from a large onshore oil field complex, close to the coast. Production started already in 1982, and in order to be able to continue to provide energy and income to the state in the future, the state oil company needed to expand their portfolio through active exploration. To that end the company has embarked on a concerted effort to explore the shallow and near-coastal offshore acreage.

Prior to an investment decision, the oil company's management required an intermediate independent technical audit, to make sure that 1) the work carried out is of industry standards, 2) has followed modern workflows, and 3) to provide advice on the main risks and uncertainties. A 1-week audit was carried out by two experienced senior exploration staff, with a presentation of the review's main findings to their senior management, and a more technical presentation to all involved staff.

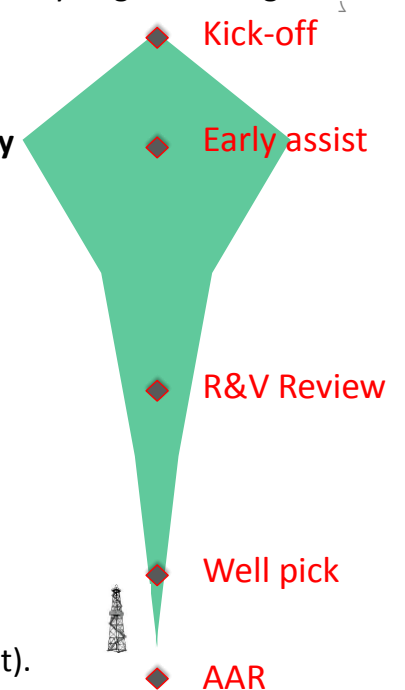
Following the audit both reviewers were invited to run 2 courses of 1 week each to all exploration staff:

- 1) Play-based Exploration, Risk & Volume Assessment,
- 2) Reservoir identification in context of sequence stratigraphy.

Because of the reviewer's earlier involvement, the courses could be tailored to the needs of the staff and company. Both reviewers were again invited to the state oil company to carry out reviews on new exploration projects. Each exploration project consists of 5 stages. The sessions earlier in the project have a very large coaching element, later during the project the review/audit aspect is the main focus.

The review sessions and evaluation process are aligned in a staged process:

- 1. Kick-off meeting: to make sure the objectives of the project are well understood, that everybody is aware of work carried out previously and of the available data, and to agree an initial workplan**
 - Divergent phase: staff familiarizes themselves with the data to better understand the main uncertainties, whilst considering different geological scenarios
- 2. Early assist: to make sure the project is on track, that the risks and uncertainties are understood and to agree the workplan for the following phase**
 - Divergent phase: carry out the agreed workplan and make sure all technical work is complete to a sufficient degree
- 3. Risk & Volume review: To make sure all work is correct and complete and to agree the exploration risks and hydrocarbon volumes**
 - Focus on value: Notional field development plans are made and exploration economics is carried out
- 4. Well pick: Check value and consistency of the project findings and agree where and how to drill the well**
 - Drill the well(s)
- 5. After Action Review: Compare the findings of the well with the predictions, and agree what has been learned**



External reviewers are involved mainly in review sessions 2 (Early Assist – with large focus on coaching) and 3 (Risk & Volume review - formal audit). Other involvement is virtual, through email exchanges and Skype sessions

The state oil company of Surinam has embarked on a PBE study of the entire offshore area: the Integrated Guiana Basin Study

- The study was started in the light of a string of discoveries in neighbouring Guiana, with reportedly more than 5 billion barrels of oil discovered
- The objective of the study is to become 'basin master' of its own basin; capable of having in-depth discussions with IOCs and of generating interest in the Surinam acreage.
- The study is based on all seismic and well data, including company confidential data.
- While the results of the study is planned to be made available to all operators, confidential data itself will not.
- The main geological provinces are the deep-water Surinam-Guiana Basin, the Demerara Plateau and the shallow-water shelf area.
- Discoveries in Guiana are all in the deep-water and rely on charge from the prolific marine Turonian hot shale.
- Oil typing has shown that also the onshore Tambaredjo field (1 BBO in place) is charged mainly from a marine type II source rock
- Several consultants have been contracted to carry out this study, together with the oil company's staff. External expertise has been contracted for the following 4 expertise areas: Seismic interpretation, structural geology, sequence stratigraphy and petroleum system analysis.
- Phase 1 of this project is planned to be completed by end 2019.
- Subsequently the objectives and timeline for a phase 2 will be decided.

Two reviews/assist sessions for this study have been carried out by Jan de Jager and Maarten Wiemer.

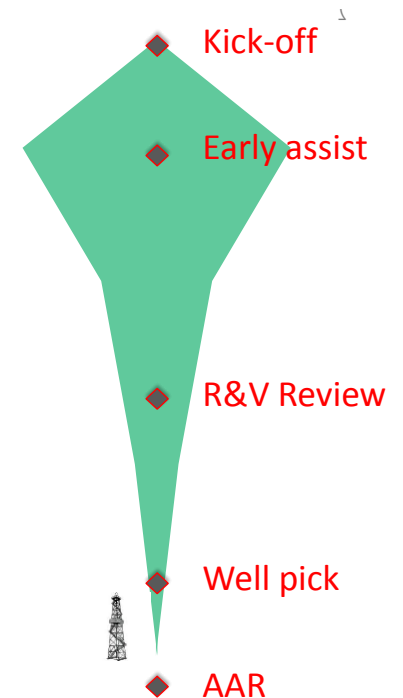
- Both sessions took 5 full days
- To make sure all team members were fully aware of the findings of all aspects of the project, the entire team working on the study was present for the initial presentations and discussions of the status and findings of the project.
- The second half of the week was available for workstation sessions to follow up any issues.
- The last day and a halve was for the reviewers to prepare a presentation to staff and a separate one to senior management.

A kick-off meeting to discuss the objective of the project as well as the approach and expected deliverables was in this case organised without the external reviewers.

De Jager and Wiemer, they have now been used as reviewers and coaches on several projects for the state oil company:

- Near Shore
- Shallow Offshore
- Integrated Guiana Basin study

As a result of their ongoing involvement in geological studies carried out in Staatsolie, both reviewers have gained an excellent understanding of Surinam's regional geology and of the data that is available from seismic and wells in Surinam.



A Canadian multinational oil and gas company had operational exploration offices in 4 locations in South-East Asia (Ho Chi Minh City, Kuala Lumpur, Djakarta, Brisbane) and a regional head office in Singapore. Interests in SE Asia were in conventional exploration, while its North American focus was mainly in unconventional oil and gas. The company had identified a need to approach their conventional exploration activities in SE Asia from a Play-based Exploration (PBE) perspective. To this end PetroEdge was asked to deliver a 3-day course on PBE to all their exploration staff. The standard PBE course that is offered by PetroEdge has a large hands-on group exercise on the construction of a Play map and supporting maps that is based on data from the Southern North Sea in West Europe.

On the request of the multinational company, the hands-on PBE exercise was redesigned using subsurface data provided by the company from the Nam Con Son Basin in the South China Sea. This made the exercise more meaningful for the company's staff. The 3-day exercise was run in all its 4 operational locations. In each location all exploration staff was present: from technical assistant up to exploration manager. This was to make sure that the PBE workflow and philosophy would indeed be adopted fully.

The PBE Pyramid

On completion of the course in each SE Asia office, staff:

- ✓ Shares a common understanding of the Play-based Exploration workflow
- ✓ Understand what is involved in the construction of Play Maps
- ✓ Understand what Common Risk Segment (CRS) maps are, and how they are constructed
- ✓ Understand the uses and differences between Play Maps and CRS maps
- ✓ Understand what Creaming curves and Field Size distributions are, and how they are constructed
- ✓ Understand how the PBE workflow leads to better exploration and more realistic predictions



Play-Based Exploration

The results of the course was judged to be well above expectations. It was decided to run the course also in the regional head office for any staff who were unable to follow the course in the operational locations and to new staff.

The PBE course can be run as the standard course, but on request customised courses can be run using (proprietary) company data.

On the request of the state oil company in Malaysia a 5-day course on Prospect maturation has been designed. In this course all main play elements involved in evaluation prospects are discussed: Traps, Reservoirs, Seals and Charge. The geological aspects of each of these play elements is discussed and illustrated with real examples are given of how they occur in different petroleum basin types across the world: Rift Basins, Deltas, Deep Water Setting, carbonate Provinces. In addition, the manner in which the geological understanding should be translated in numbers and ranges of numbers that can be used in probabilistic Risk & Volume Analysis is presented. The course is exercise-rich and includes exercises on risk assessment and calculation of potential hydrocarbon volumes in undrilled prospects. In the course there is significant attention for applying realistic uncertainty ranges.

The course director is an acknowledged expert in Risk & Volume assessment, and has good hands-on understanding of the probabilistic tools that are used in the industry to assess the Probability of Success (POS) and volume ranges for undrilled prospects.

On completion of the course participants:

- ✓ Understand the geology of Traps, reservoirs, Seals and Charge
- ✓ Understand how these play elements can be expected to occur in different basin settings
- ✓ Understand how to translate geological understanding in realistic numbers and ranges
- ✓ Know how to read the results of probabilistic volume calculations
- ✓ Understand the meaning of Mean Success Volumes (MSV), and of P90, P50 and P10 volumes
- ✓ Understand that the input of uncertainty ranges must be based on geological understanding

After an initial try-out the course was considered to be of such importance that it became a standard course to be followed by all of the state oil company's exploration staff. Since its inception, the course has been delivered in many locations around the world as public course. Santos (in South Australia) also considers this a course that should be run for all their staff as an in-house course.

When the course is run in-house there is the possibility to discuss the geology, risks and uncertainties of company prospects, and how they should be treated in a meaningful and realistic Risk & Volume assessment